

*Zimmerwald Dual-Wavelength  
Operation: First Experiences*



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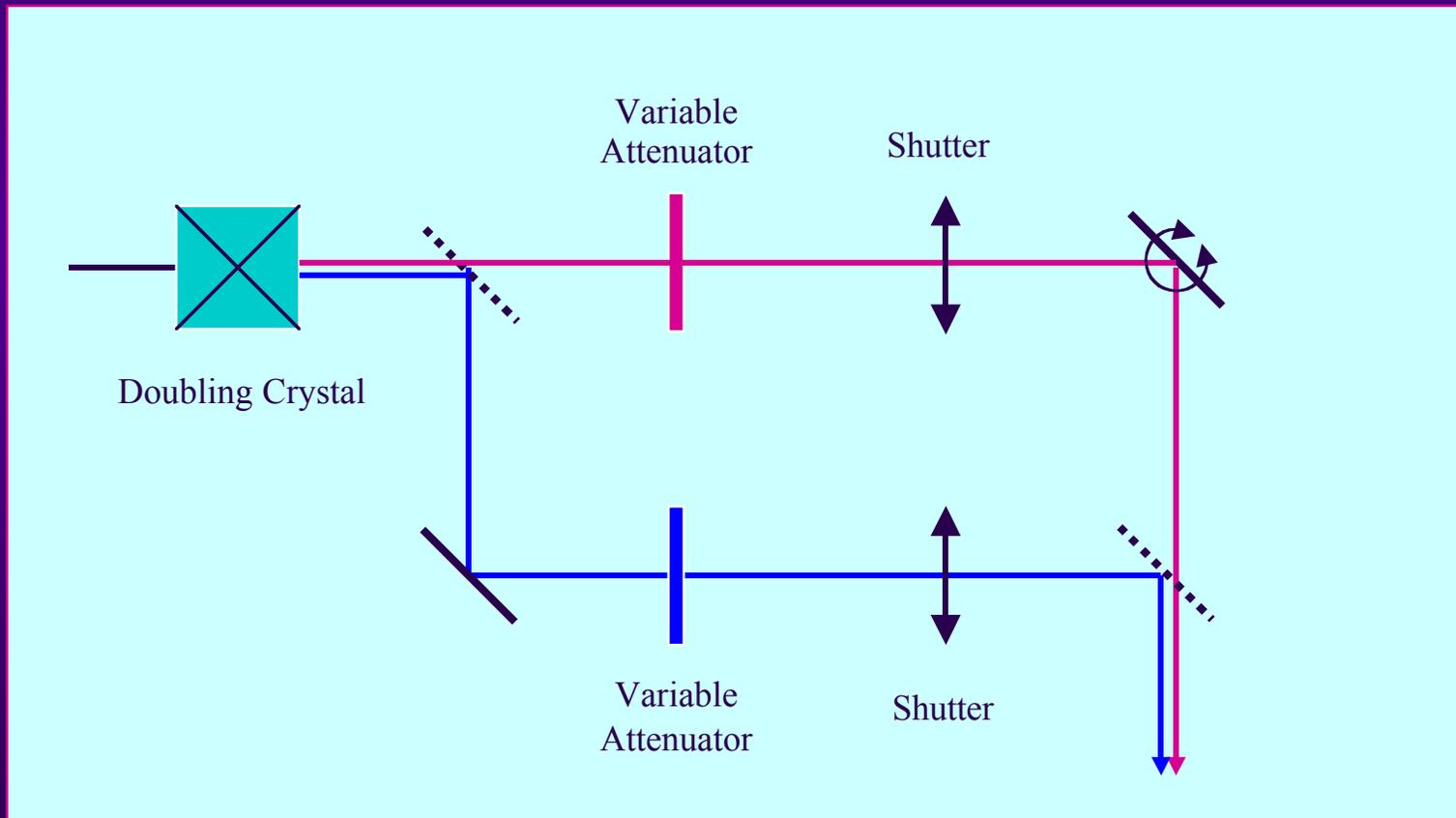


## *Two-Wavelengths Design*

- ◆ Coudé path optics designed for two wavelengths: 423 nm and 846 nm
- ◆ Mirror coatings in telescope optimized for the two wavelengths
- ◆ Transmit and receive paths designed for separate beam control (shutters, attenuators, filters)
- ◆ Receivers
  - ◆ Blue (423 nm): Hamamatsu PMT and CSPAD
  - ◆ IR (846 nm): Hamamatsu PMT

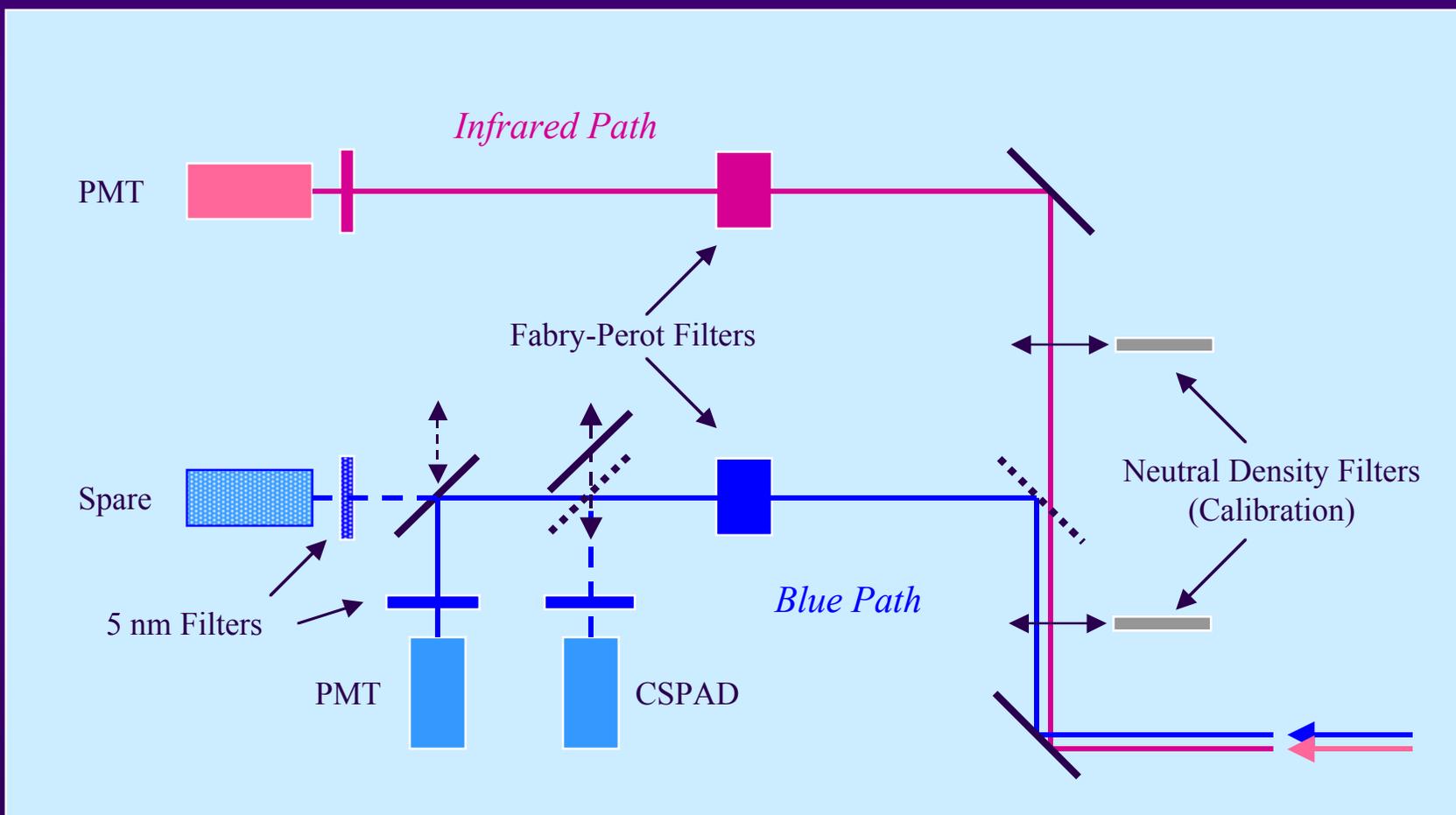


# *Transmit Path*





# Receiving Path

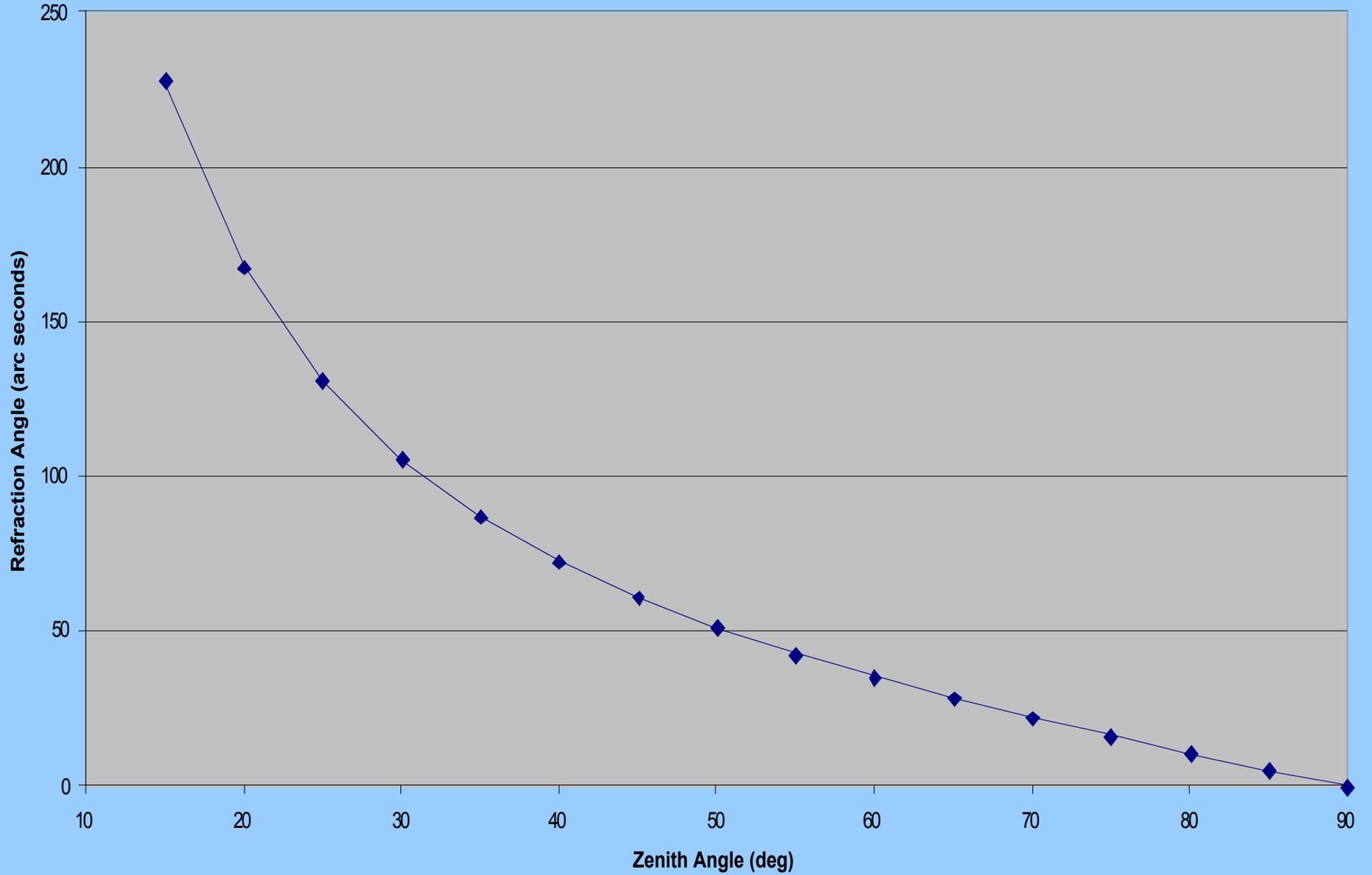




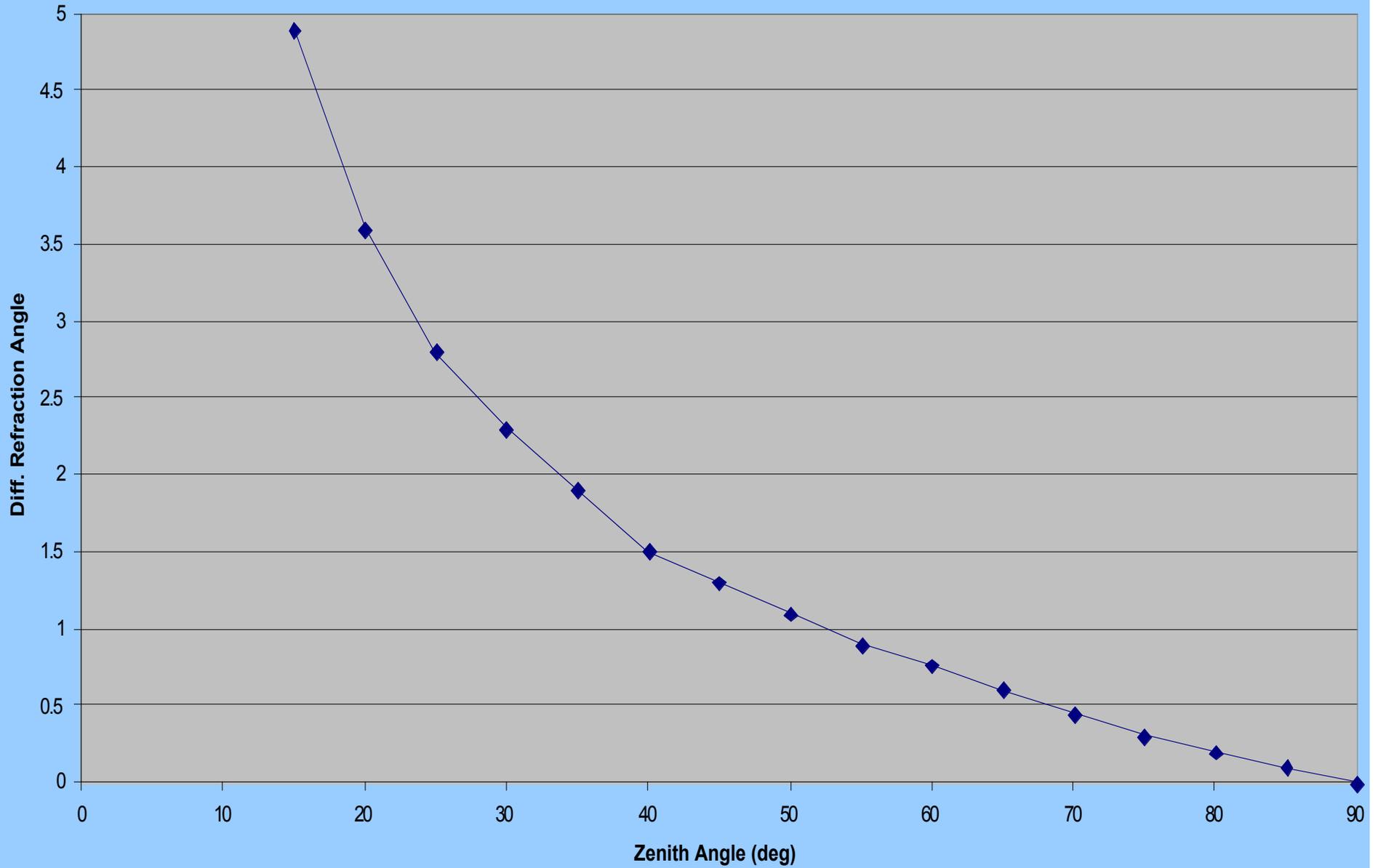
## *Beam Alignment*

- ◆ **Blue and infrared laser beams:**
  - ◆ Transmitting beams parallel to 1-2 arc seconds by adjustment (goal)
  - ◆ Differential refraction: 0 to 4 arc seconds:
    - ◆ Transmitting beam: Beam divergence
    - ◆ Receiving path: Field of view
  - ◆ Receivers: Aligned to field of view pinhole

# Atmospheric Refraction



# Differential Refraction 423 nm - 846 nm





## *Beam Attenuation*

- ◆ Goal: Keep both return rates below 20 to 30 percents
- ◆ Transmitting beams
  - ◆ Separate rotating polarizer for each color
- ◆ Receiving paths
  - ◆ Common neutral density filter for calibration
  - ◆ Additional ND filter for infrared only
  - ◆ Circular adjustable ND filter as attenuator in preparation



## *Satellite Acquisition*

- ◆ At the beginning of each pass and after breaks: Measured flight times are automatically screened for true returns
- ◆ After this initialization phase: Update current time bias with each successful return to improve range prediction and realtime screening
- ◆ Tracking software modified to use both, blue and IR measurements



## *Dual-wavelength Data Submission*

- ◆ Data and Analysis Centers: Asked to get prepared to accept dual-wavelength normalpoint data
- ◆ Got OK from CDDIS in July and EDC early August 2002
- ◆ Dual-wavelength data submission started on August 14, 2002
- ◆ Some problems with
  - ◆ Data Center statistics
  - ◆ Analysis Center weekly reports

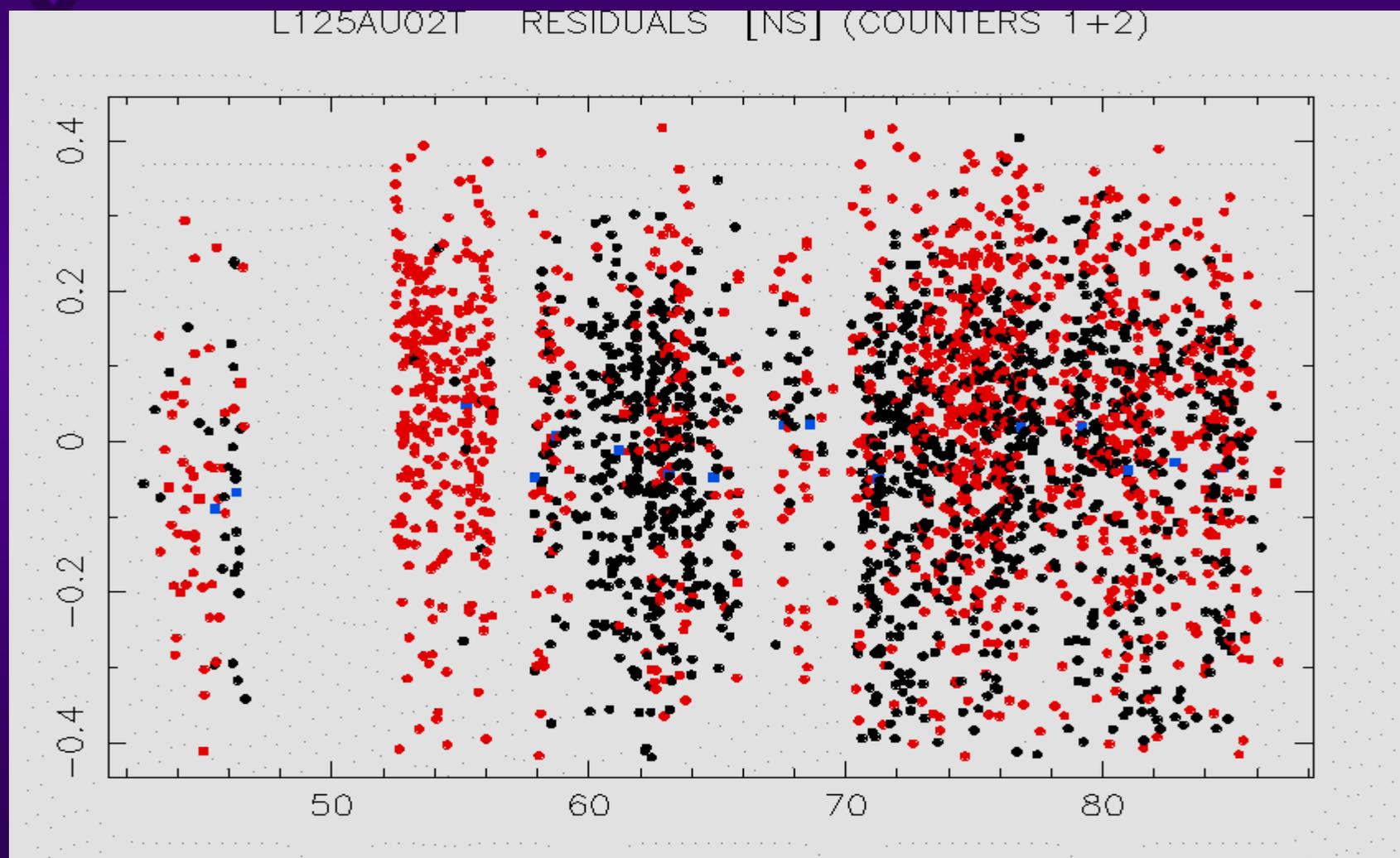


*Example: Lageos-1 Pass*  
*25 August 2002, 19:40-20:30 UT*

Wavelength	Single shot observations	Single shot RMS	Calibration RMS	Number of Normalpoints	Average difference
Blue 423 nm	1323	0.16 ns	0.12 ns	18	0.05 ns
IR 846 nm	1337	0.18 ns	0.23 ns	21	



## *Lageos-1 Blue and IR Residuals (ns)*

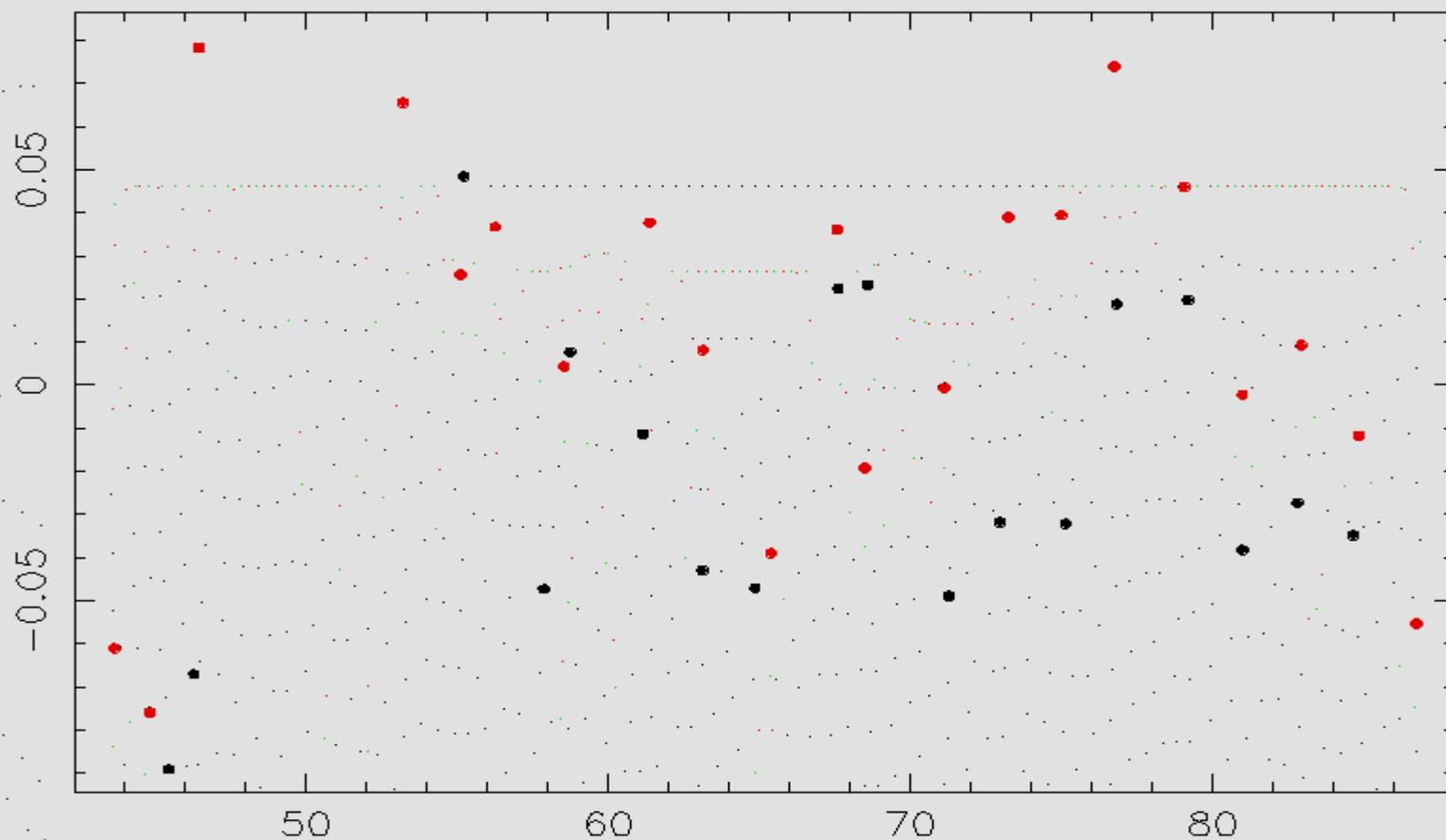




# *Lageos-1*

## *Blue and IR Normalpoint Residuals (ns)*

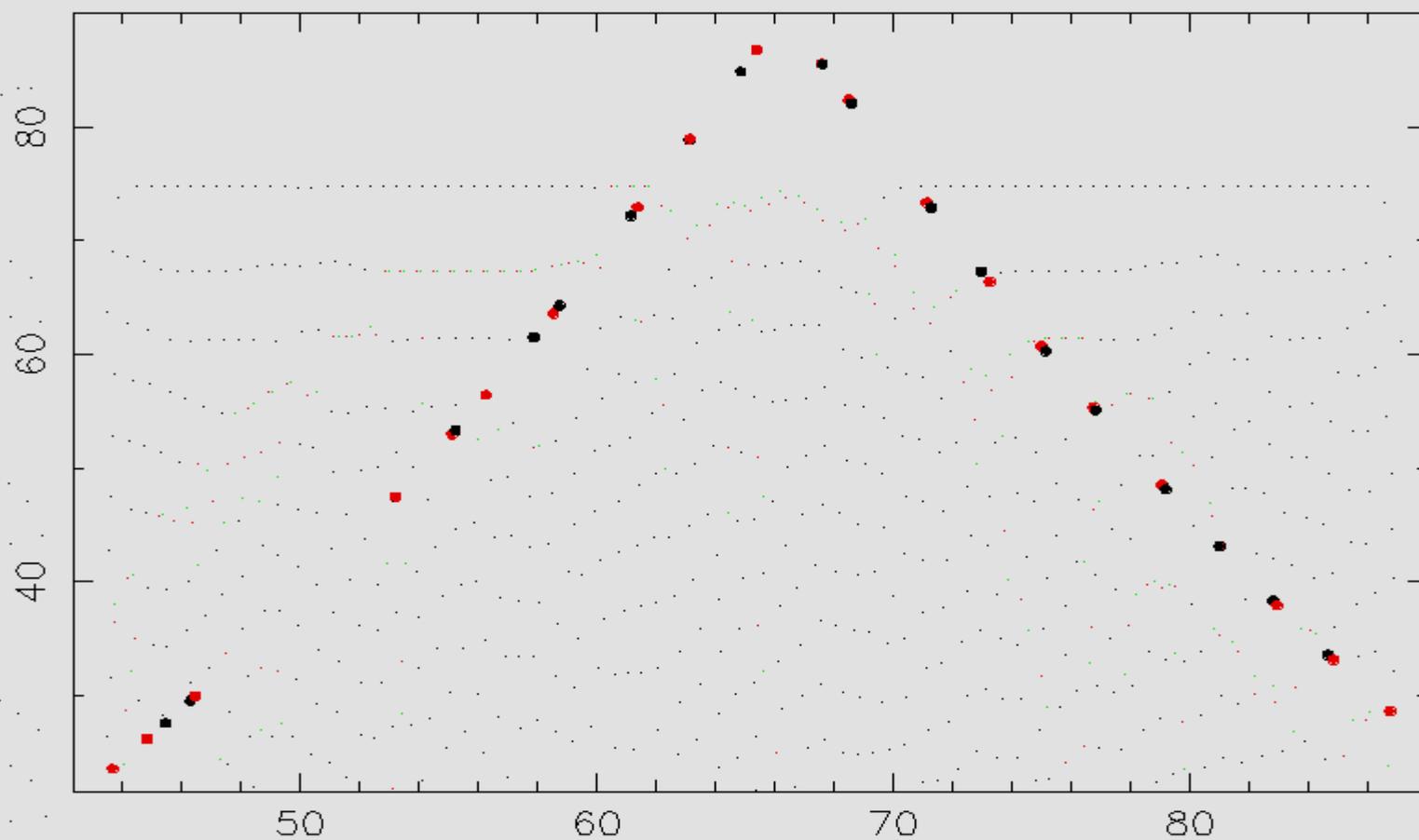
L125AU02T NORMAL POINT RESIDUALS (COUNTERS 1+2)





# *Lageos-1 Elevations (deg)*

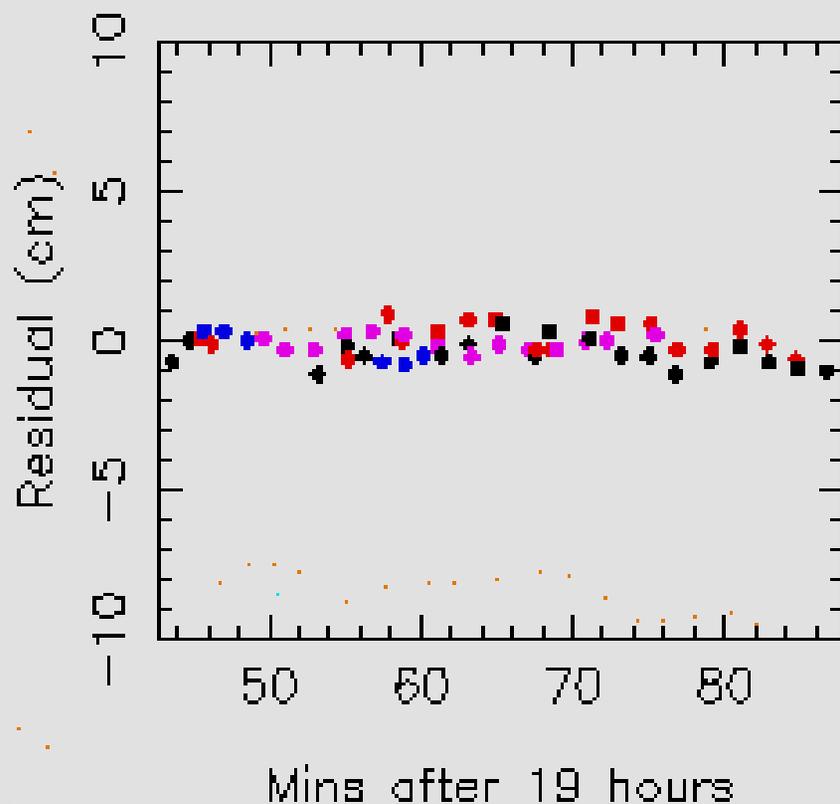
L125AU02T ELEVATION (COUNTERS 1+2)





# *NERC Short Arc Analysis*

2002-Aug-25



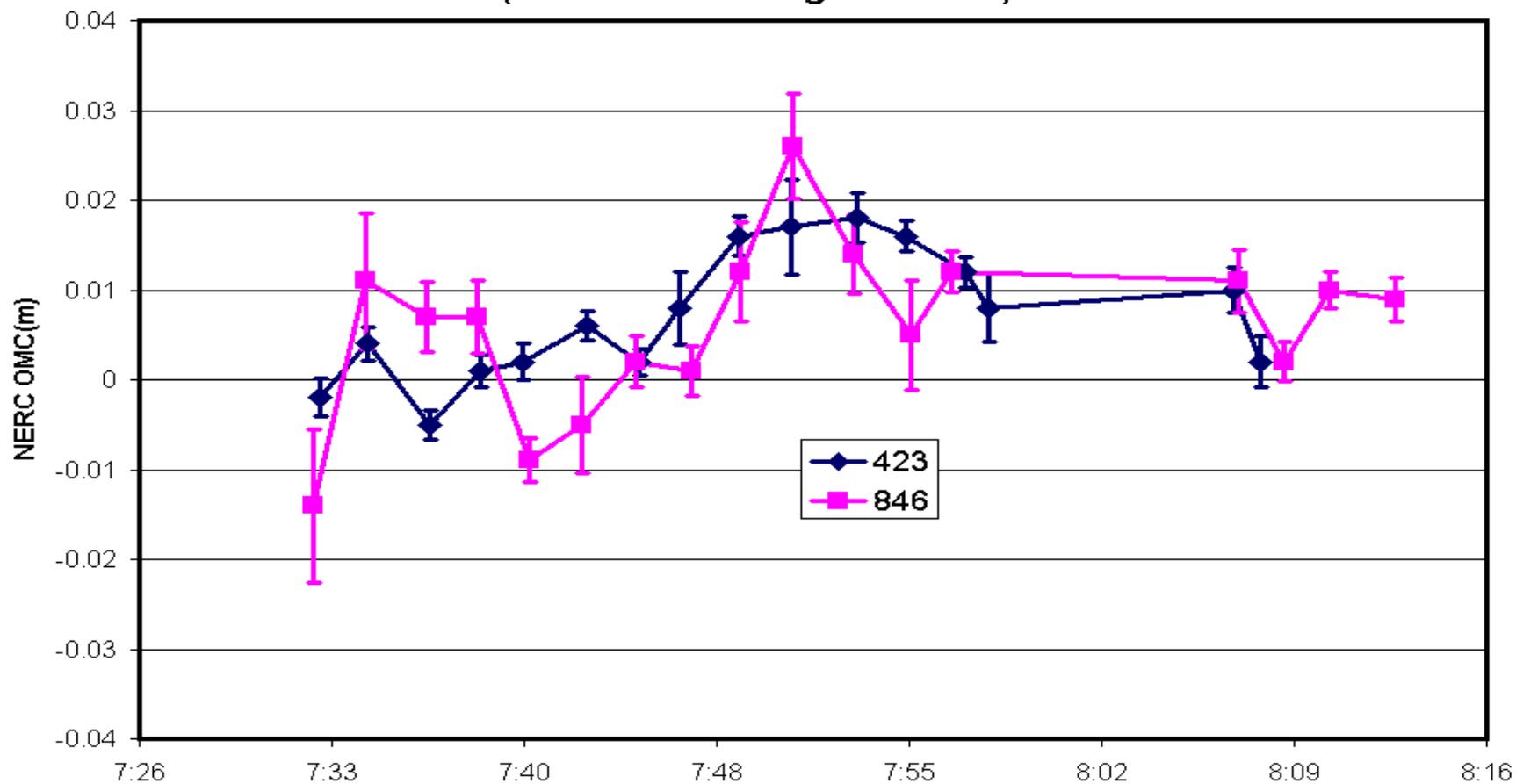
Station Zimmer-IR  
Satellite Lageos-1

8810 Zimmer-IR  
7810 Zimmerwald  
7839 Graz  
7840 Herstmonceux



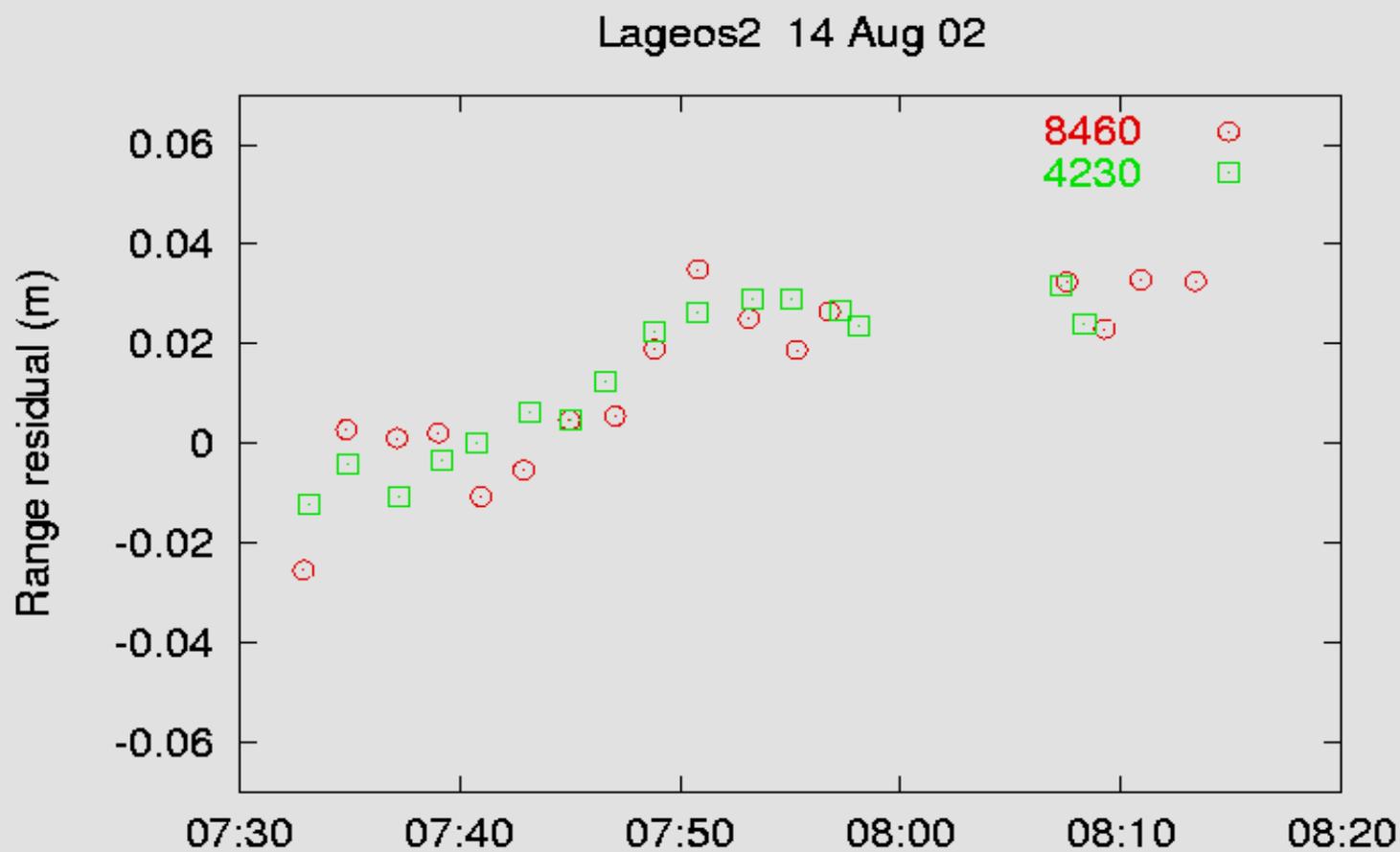
# Lageos-2: NERC Long Arc Analysis + NPT Statistics

Zimmerwald 2-color Analysis  
(LAGEOS-2 on Aug 14 at 7:32)





## *CRL Analysis*





## *Experiences*

- ◆ Beam alignment is rather critical
- ◆ Somewhat less noise in the infrared channel during daylight tracking
- ◆ Not clear yet under which conditions we get more IR than blue returns
- ◆ Calibration RMS on IR larger by at least 100 percents (0.2 vs. 0.1 ns)
- ◆ Average pass differences IR-blue (after M.M.-correction)  $< 0.05$  ns



## *Conclusions*

- ◆ Range biases between the two reception channels could still be in the system (a few millimeters?)
- ◆ No systematic behavior detectable till now
- ◆ Differences of the Marini-Murray refraction corrections at 423 and 846 nm obviously better than  $< 8$  mm
- ◆ Is accuracy of the two wavelengths good enough for mapping function improvement?